HEALTH CONSULTATION

Review of February 2000 Soil Data

AMOCO-SUGAR CREEK
(a/k/a AMOCO OIL COMPANY)

SUGAR CREEK, JACKSON COUNTY, MISSOURI

EPA FACILITY ID: MOD007161425

Prepared by:

Petition Response Section
Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

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U.S. Department of Health and Human Services

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List of Acronyms and Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
BTEX	Benzene, toluene, ethyl benzene, and xylenes
CREG	Cancer risk evaluation guide
EFR	Enhanced fluid recovery
EMEG	Environmental media evaluation guide
EPA	U.S. Environmental Protection Agency
kg	Kilogram
LPG	Liquified petroleum gases
MDNR	Missouri Department of Natural Resources
mg	Milligram
MRL	Minimal risk level
ND	Not detected
PAHs	Polycyclic aromatic hydrocarbons
ppm	Parts per million
RBC	Risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RMEG	Reference dose media evaluation guide
SCVs	Soil comparison values
SVOCs	Semi-volatile organic compounds
TFE	Total fluids extraction
µg	Microgram
VOCs	Volatile organic compounds

Purpose and Health Issues

The Agency for Toxic Substance and Disease Registry (ATSDR) was petitioned on June 13, 1998, for a public health assessment of the Amoco Oil Company site in Sugar Creek, Missouri. The Norledge area, adjacent to the southern boundary of the site, is an area at particular risk for off-site migration of contaminants. The Norledge area of Sugar Creek encompasses approximately 130 residences. ATSDR released a public health assessment for public comment in May 1999 that concluded the Norledge area poses an *Indeterminate Public Health Hazard.* This determination was made because no soil data were available from the 0–3 inch depth range. ATSDR recommended that samples of surface soil (top 0–3 inches) be collected in the Norledge area to determine if current levels of contaminants are of public health concern. In response, the U.S. Environmental Protection Agency (EPA) collected surface soil samples in February 2000. ATSDR issued a health consultation evaluating these soil data for public comment on May 1, 2000. This health consultation addresses the public comments received by the agency.

Background

Site Description

The Amoco Oil Company began petroleum refinery operations in Sugar Creek, Missouri, in 1904. Crude oil was brought in by pipeline from several states to produce gasoline, distillate fuels, jet fuels, residual fuels, asphalt, petroleum coke, liquefied petroleum gases (LPG), sulfur, and polymers (TriTechnics Corporation 1995). Although petroleum refinery operations ceased in 1982, Amoco has continued to use portions of the site as a light oil petroleum-product marketing terminal, a pipeline facility, and an asphalt receiving and processing center (TriTechnics Corporation 1995).

While the refinery was operational, the site consisted of numerous process units. In addition to these process units, several storage tank areas existed. Leaded gasoline and naphtha were used onsite (EPA 2001b). Numerous spills and leaks occurred throughout the site.

Land Use

The Amoco site occupies approximately 500 acres on both sides of Sugar Creek (see Figure 1, Appendix A). The Missouri River bounds the site to the north, wooded areas are on the East Bluff and West Bluff, and residential areas are to the south (TriTechnics Corporation 1995). The Norledge area is located adjacent to the south side of the site. The Atchison, Topeka & Santa Fe and Missouri Pacific railroad lines run through the northern portion of the site.

Demographics

According to the 2000 U.S. Census of Population and Housing (Bureau of the Census 2001), the demographic statistics for locations within 1 mile of the Amoco site indicated there were 9,708 persons residing in 4,446 households. Of these, 92.2% were white; 1.4% were black; 0.7% were American Indian and Alaska Native; 0.6% were Asian; 1.0% were Native Hawaiian and Other Pacific Islander; 1.6% were members of other races; and 2.5% were members of two or more races. There were 927 children 6 years of age or younger, and 1,393 adults 65 years of age and older. Figure 2, Appendix A, lists additional demographic statistics.

Remediation and Sampling Activities in the Norledge Area

Amoco refinery operations were regulated under the Resource Conservation and Recovery Act (RCRA). When refinery operations ceased, a RCRA Facility Investigation (RFI) identified potential sources, areas, and characteristics of contamination to be investigated (TriTechnics Corporation 1995). Since the 1995 RFI report was submitted, EPA and the Missouri Department of Natural Resources (MDNR) have taken a different approach to completing the RFI process. In response to public concern, the agencies have focused most of the investigation in the off-site plume area. Amoco has since submitted an RFI report focused solely on the off-site plume area. This was done to expedite investigations and to implement clean-up activities in the off-site area. Subsequent investigations will be conducted in a phased manner for the remainder of the site (EPA 2001a).

Groundwater investigations have identified one off-site area of benzene contamination and two off-site areas of free product (that is, free floating petroleum) contamination in the Norledge area (TriTechnics Corporation 1995). Amoco began efforts to recover free product in the late 1950s and to control the migration of hydrocarbons dissolved in groundwater in the 1960s by building interceptor drain systems and trenches (TriTechnics Corporation 1995). This program was expanded in the 1970s and 1980s with the construction and expansion of the Norledge Interceptor Trench Recovery Network. In addition to the interceptor trench, interim measures include enhanced fluid recovery (EFR) and total fluids extraction (TFE) (BP 2002).

Amoco conducts biweekly EFR on wells in the Norledge area. During the EFR process, a vacuum truck extracts fluid and vapors from each well. Free product is collected for recycling, contaminated groundwater is sent to a treatment system, and vapors are treated in activated carbon canisters. To maximize the effectiveness of the process, the EFR locations are adjusted periodically (BP 2003). Since this EFR activity began, levels of contamination have decreased (EPA 2002). EFR has been successful in assisting in the natural attenuation of VOC concentrations in groundwater and benzene concentrations have been decreasing (BP 2003). Monitoring wells located in the Norledge area are monitored and sampled quarterly. EFR will continue until a final corrective remedy is approved and installed (BP 2003).

The TFE system is similar to the EFR system in that fluids—including groundwater, free product, and soil vapor—are removed. Additionally, TFE stimulates the biodegradation of hydrocarbons by introducing oxygen through the subsurface (BP 2002). The TFE system consists of nine horizontal wells. The first two horizontal recovery wells were installed and pilot-tested in late 1999. Seven additional horizontal wells started operations in early 2001. As of April 2002, the TFE system met shutdown criteria and the confirmation monitoring program began (BP 2003). Approximately 87,300 pounds of hydrocarbon were removed during the system's operation, with the greatest mass removed through biodegradation (68,600 of the 87,300 pounds) (BP 2003).

Underground pipelines are also being investigated. Starting in the 1970s, Amoco began to replace underground pipelines with above-ground pipelines to reduce the potential for undetected releases (TriTechnics Corporation 1995). (Amoco's active pipelines currently enter the site from the eastern and northern borders.) Two of Amoco's old product pipelines run through the Norledge area — one along Northern Street and one along Carlisle Street. Williams Natural Gas currently owns the pipeline that runs along Northern Street. That line supplies natural gas to the local power plant. The line that runs along Carlisle Street was abandoned in the early 1980s (EPA 2001a). The decommissioned underground lines were flushed with water in 1986–1987. However, a leaking pipe in a tank dike indicated that some product remained in the lines after the flushing occurred. EPA asked that Amoco prepare a plan for investigating underground pipelines. As part of future investigations, Amoco will address underground piping and other subsurface structures (EPA 2001b).

Overall, remedial activities in the Norledge area should result in a decrease in contaminant concentrations in the future.

Discussion

ATSDR evaluates contaminants detected in environmental media at hazardous waste sites and determines whether an exposure to the contamination has public health significance. ATSDR begins this evaluation by reviewing environmental data to determine if the levels of contaminants are above health-based comparison values. Health-based comparison values are media-specific concentrations of chemicals that have been determined to be unlikely to result in adverse health effects. Refer to Appendix C for further information on health-based comparison values.

Once the environmental data have been obtained and evaluated, ATSDR staff members determine whether people are exposed to the contaminants. Refer to Appendix D for further information on ATSDR's methodology. ATSDR staff members determined that a current completed exposure pathway to contaminated surface soil exists, and will exist in the future, for residents of the Norledge area (see Appendix B, Table 1). Adults and children could contact contaminated surface soil during such activities as gardening, playing, and bicycle riding. Skin contact, ingestion, and inhalation (of dust) would be the primary routes of exposure. Ingestion of soil usually occurs by the inadvertent consumption of soil on hands or food items, mouthing of objects, or the

intentional ingestion of nonfood items (pica behavior). Groups that are at an increased risk for pica behavior are children aged 1–3 years old (ATSDR 1992c).

EPA collected surface soil samples primarily from the Norledge area in February 2000. A few samples were collected outside the Norledge area, east of Sterling Avenue. Most of the samples were collected at the 0–3 inch depth range, with the exception of a garden sample collected at the 8–12 inch depth range. The samples were collected from areas where adults and children would have frequent access, including a garden and playgrounds. Of the 26 samples collected, 17 were composite samples and nine were grab samples. Seventeen composite samples were analyzed for semi-volatile organic compounds (SVOCs) and metals. Nine grab samples were analyzed for volatile organic compounds (VOCs) and metals. The soil grab samples were analyzed for VOCs, including benzene, toluene, ethyl benzene, and xylenes (BTEX), but none were detected. Appropriate quality assurance and quality control procedures were followed. Table 2, Appendix B, contains the results of the February soil sampling effort (EPA 2000).

Benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd) pyrene exceeded the ATSDR cancer risk evaluation guide (CREG) comparison value for benzo(a)pyrene (ATSDR 1995). Benzo(a)pyrene itself was not detected. ATSDR has no comparison values for benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, or indeno(1,2,3-cd)pyrene in soil. Therefore, the CREG for benzo(a)pyrene, the most toxic of the natural polycyclic aromatic hydrocarbons (PAHs), was used as a surrogate comparison value for all of the PAHs. This is a conservative procedure; benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene were not detected in most of the composite samples collected. The estimated exposure doses of these PAHs are orders of magnitude below all known effect levels, also. No adverse health effects, including cancer, would be expected from exposure to soils containing these PAHs at the levels detected.

Arsenic detected in the soil samples also exceeded its CREG of 0.5 parts per million (ppm). Of the 26 surface soil samples analyzed, arsenic was detected in one composite soil sample at a level of 8.22 ppm. The U.S. Department of Health and Human Services, the International Agency for Research on Cancer, the National Toxicology Program, and the EPA have all independently determined that arsenic is carcinogenic to humans. However, there are no studies that specifically address the carcinogenic potential of arsenic in contaminated soil. For oral (ingestion) exposure, this conclusion is based primarily on studies performed in non-U.S. populations exposed to high levels of arsenic in drinking water. Outside the United States, skin cancer is consistently associated with chronically high oral exposures to arsenic from drinking water. It is sometimes associated with an increased risk of certain internal cancers (especially bladder cancer), as well (Tseng et al. 1968, Wu et al. 1989, Chen et al. 1986, Bates et al. 1992, NRC 1999). However, U.S. studies have revealed no increase in bladder cancer associated with arsenic in drinking water (Lamm et al. 2004, Steinmaus et al. 2003). Studies have not established any increased skin cancer risk in U.S. populations exposed to 100–200 ppb arsenic in drinking water (Goldsmith et al. 1972; Harrington et al. 1978; Morton et al. 1976; Southwick 1981; ATSDR 2000a, p. 121). Virtually all of the 300 or so cases of arsenical skin cancer (as opposed to actinic or sunlight-related skin

cancer) recorded in the United States have been associated with past occupational exposures (Stohrer 1991). One likely reason for the apparent absence of drinking water-related arsenical cancers in the United States is that levels of arsenic in U.S. drinking water supplies are generally quite low, averaging <5 ppb. In contrast, arsenic concentrations in drinking water in Taiwan, Mexico, Chile, Bangladesh, or India, may be in the hundreds, or even thousands, of parts per billion (ATSDR 2000a, p. 260–6). This difference is important because, compared to mutagen-induced cancer, arsenical cancer is a relatively high threshold effect that does not involve direct damage to DNA (Marcus and Rispin 1988; Stohrer 1991; ATSDR 2000a, p. 176 and 188). The human body also has the ability to rapidly detoxify low doses of arsenic (Marcus and Rispin 1988). Of additional relevance to the soil exposure pathway is the fact that the bioaccessibility and bioavailability of arsenic are much lower in soil (3%–50%) than water (ATSDR 2000a, p. 136). Ingestion of soil from this residential area is unlikely to produce any arsenic-related carcinogenic adverse health effects for the following reasons: arsenic is not as bioavailable in soil as in water, the human body has the ability to detoxify low doses of arsenic, and arsenic in soil would only be an intermittent exposure (as compared to drinking water every day, all year).

When this health consultation was released for public comment in May 2000, several compounds (including arsenic) exceeded ATSDR's soil comparison values (SCVs) for pica children, but not those for non-pica children or adults. Specifically, several compounds exceeded chronic duration (for a year to a lifetime) pica child SCVs and intermediate duration (2 weeks to a year) pica child SCVs. Recently, however, ATSDR began to eliminate its pica child SCVs because several factors make it unlikely that a pica child could receive a toxic dose of chemicals from soil ingestion, alone. Some of these factors include the following:

- Pica children tend to exhibit pica behavior only intermittently, not continually, for the first 1 to 3 years of their lives.

- Pica child comparison values do not take into account that pica children do not remain pica children for a lifetime.

- A very small percentage of children routinely exhibit pica behavior. In one study of soil ingestion by children, only 1 in 320 children (0.3%) ingested as much as 5,000 milligrams (mg) soil in a single day. Ninety-five percent of the children studied ingested less than 100 mg soil per day (ATSDR's estimated ingestion rate for adults), and the average was only 40 mg soil per day (Gough 1991).

- None of ATSDR's SCVs are based on studies involving soil as the medium of exposure. All are extrapolated from studies of exposure via other media (usually drinking water or gavage oil in animals), without taking into account the reduced bioavailability of substances in soil relative to their bioavailability in other media.

Chronic-duration pica child SCVs have already been eliminated. Because this process is not yet complete, ATSDR chose to discuss, in the following text, those compounds which exceeded the agency's pica values in soil samples taken (primarily) from the Norledge area.

As stated previously, arsenic was detected in one composite surface soil sample at a level of 8.22 ppm. This detection of arsenic in soil exceeded ATSDR's former chronic environmental media evaluation guide (EMEG) for pica children. This level did not exceed the chronic EMEGs for non-pica children or adults (ATSDR 2000a). ATSDR's default pica child comparison value assumes a child weighs 10 kilograms (kg) and ingests 5,000 mg of soil per day. On the basis of these assumptions, a pica child exposed to 8.22 ppm arsenic in soil receives an arsenic dose of 0.0041 mg/kg/day. This arsenic dose is less than ATSDR's acute minimal risk level (MRL) of 0.005 mg/kg/day. Actual exposures are likely to be considerably lower, because only a portion of arsenic in ingested soils is eventually absorbed into the human body. Neither the site-specific exposure estimates, nor the cited soil comparison values, take this reduced bioavailability into account. Several epidemiologic studies of moderate-sized populations (20 to 200 people) exposed to arsenic through drinking water have detected no dermal or other effects at average chronic doses of 0.0004 to 0.01 mg/kg/day (Mazumder et al. 1988, Valentine et al. 1985, Cebrian et al. 1983, Southwick et al. 1981, Harrington et al. 1978). Drinking water arsenic exposures would occur every day via ingestion, while exposures to soil would occur sporadically during the warmer months and would not necessarily include ingestion of 5,000 mg of soil each day. Therefore, ATSDR does not expect that pica child ingestion of soil would result in any arsenic-related noncarcinogenic adverse health effects.

The maximum detected concentration of cadmium exceeded ATSDR's former chronic pica child EMEG (0.4 ppm). High chronic doses of cadmium, by either inhalation or ingestion, can be toxic to the kidneys (ATSDR 1999). However, chronic cadmium toxicity is not a feasible outcome of soil ingestion, even for a pica child, in the Norledge area. Although the maximum detected cadmium concentration in soil (2.74 ppm) exceeded by a factor of 6.85 ATSDR's former chronic pica child EMEG (and no other comparison value), this EMEG is 10 times lower than a concentration that would be expected to produce no adverse health effects in human beings. Therefore, the highest detected level of cadmium in Norledge soils would be too low to produce adverse health effects, even assuming pica-behavior exposure conditions. Because cadmium was not detected in half of the 26 samples collected, realistic average exposures would be much lower. In addition, ATSDR's cadmium MRL (and, hence, all of the comparison values derived from that MRL) is based on cumulative lifetime exposures to cadmium in drinking water. Lifetime drinking water exposures are not directly comparable to the pica-soil exposure scenario. The former involves chronic, long-term exposure to soluble (i.e., more bioavailable) forms of cadmium. The latter involves intermittent, relatively short-term (1–3 years) exposures to less soluble, and less bioavailable, forms of cadmium. Further, any potential effect of cadmium in Sugar Creek soils might be reduced by zinc and cobalt, which were also detected in soil samples in the Norledge area and actually protect against the adverse effects of cadmium exposure. Therefore, ATSDR does not consider the levels of cadmium found in soil in the Norledge area to pose a threat to public health.

The maximum detected concentration (0.16 ppm) of hexachlorobenzene exceeded ATSDR's former chronic pica child EMEG (0.04 ppm). Concentrations of vanadium (maximum of 39.0 ppm) exceeded ATSDR's intermediate pica child EMEG (6 ppm). Neither contaminant exceeded ATSDR's SCVs for non-pica children or adults (ATSDR 1992b, ATSDR 1996).

Hexachlorobenzene was detected in only 1 of 17 composite soil samples. While that one sample was 4 times higher than ATSDR's former chronic pica child EMEG, this EMEG is 300 times lower than a minimally adverse effect level. The measured concentration of vanadium in Norledge area soil was 39 ppm. Although 6.5 times higher than a comparison value (the intermediate pica child EMEG of 6 ppm), that concentration is 100 times lower than a level that would not be expected to produce any observable adverse health effects. (In other words, hexachlorobenzene and vanadium concentrations in Norledge soils exceeded ATSDR's pica child comparison values by maximum factors of 1.3% and 6.5%, respectively. Those are small compared to the respective safety factors built into those comparison values.) Considering the concentrations involved at the site and the limitations of pica child EMEGs, ATSDR does not consider the levels of hexachlorobenzene and vanadium found in soil in the Norledge area to pose a threat to public health.

Barium, chromium, and manganese exceeded ATSDR's reference dose media evaluation guide (RMEG) for pica children, but not those for non-pica children or adults (ATSDR 1992a, ATSDR 2000b, ATSDR 2000c). As mentioned previously, chronic pica child comparison values do not take into account that pica children do not remain pica children for 70 years. Furthermore, the barium soil RMEG for pica children (100 ppm) is only 3% of the average concentration of barium in Brazil nuts, (i.e., 3,000–4,000 ppm) (Goyer 1991). The comparison value used for chromium in Table 2 was that for hexavalent chromium—the toxic form—although only about 15% of the total chromium in environmental samples is hexavalent chromium. Even if all of the detected chromium in soil in the Norledge area were hexavalent chromium, the levels were sufficiently low that any intake from soil would be converted by stomach acid into the trivalent form of chromium, an essential nutrient. Manganese, too, is an essential nutrient, and it is not likely anyone would receive a toxic dose of manganese from soil alone. ATSDR does not consider any of the metals detected in soil in the Norledge area to pose a threat to public health.

Conclusions

Adults, children, and pica children are exposed to soil in the Norledge area during activities such as gardening or playing. Although exposure is occurring, the contaminant levels detected in soil during a February 2000 soil sampling event are not likely to be associated with adverse health

effects. ATSDR therefore categorizes exposures to soil in the Norledge area as presenting *No Apparent Public Health Hazard*[*].

Recommendations

ATSDR has no specific recommendations.

Public Health Action Plan

The actions described in this section are designed to ensure that this public health assessment identifies public health hazards and provides a plan of action to mitigate and prevent adverse health effects resulting from exposure to hazardous substances in the environment. In addition, the results of each ATSDR site-specific activity and evaluation are provided. Where applicable, ATSDR includes a commitment to follow up on this plan and ensure that it is implemented.

Actions Completed:

■ May 3, 1999: ATSDR reviewed and provided comments to the Missouri Department of Health regarding their report entitled, "The Sugar Creek Cancer Inquiry Report—Level 2 Investigation, March 23, 1999."

■ May 7, 1999: ATSDR released its first public health assessment for public review and comment. ATSDR concluded in the initial public comment version that the Norledge area of Sugar Creek poses an *Indeterminate Public Health Hazard*[†] because only limited data for indoor air were available and no data for surface soil were available. ATSDR's recommendations included sampling indoor air and surface soil.

■ May 1999: ATSDR released an easy-to-understand fact sheet summarizing our findings from the May 1999 public health assessment document. This fact sheet was included as an insert in the *Sweet Talk Newsletter* released in June 1999.

■ June 2, 1999: ATSDR conducted a public meeting and public availability sessions during the comment period of the May 1999 public health assessment to address questions about the document and to collect additional community concerns.

∗ The phrase "No Apparent Public Health Hazard" is a formal conclusion category that ATSDR reserves for sites where human exposure to contaminated media is occurring, has occurred in the past, or will occur, but the exposure poses no health hazard.

† The phrase "Indeterminate Public Health Hazard" is a formal conclusion category that ATSDR reserves for sites at which, due to the unavailability of critical information, no determination can be made regarding the existence or non-existence of a potential threat to health in the community.

- September 1999: ATSDR published an article in the *Sweet Talk Newsletter* to provide residents with an update on our activities in the Sugar Creek Community.

- March 29, 2000: ATSDR released a public health assessment addendum for public review and comment. ATSDR determined that current, chronic exposures to the contaminant levels detected in indoor air are not likely to be associated with adverse health effects.

- April 2000: ATSDR released an easy-to-understand fact sheet summarizing our findings from the March 2000 public health assessment addendum. This fact sheet was included as an insert in the *Sweet Talk Newsletter* released in May 2000.

- April 12, 2000: ATSDR released a health consultation, "Review of January 2000 Air Data," for public review and comment. ATSDR determined that the contaminant levels detected during an indoor air sampling event are not likely to be associated with adverse health effects.

- May 1, 2000: ATSDR released this health consultation, "Review of February 2000 Soil Data," for public review and comment. It determined that no adverse health effects would be expected from exposure to this soil during activities such as gardening or playing.

- June 27, 2000: ATSDR reviewed and provided comments to the Missouri Department of Health regarding their report entitled, "The Sugar Creek Cancer Inquiry Report—Level 3 Investigation, March 3, 2000."

- August 28, 2000: ATSDR released a health consultation, "Surface Water and Sediment Data Review," for public review and comment. The health consultation evaluated surface water and sediment data provided by the Missouri Department of Natural Resources. Using the data provided, ATSDR determined that surface water and sediment contaminants are not a public health threat to residents in the Norledge neighborhood. However, because the data were limited, ATSDR recommended additional surface water and sediment sampling in the off-site portions of Sugar Creek.

- November 29, 2000: ATSDR's May 1999 public health assessment was released in final form, including the agency's responses to comments received on the initial public comment version. ATSDR concluded that short-term exposures to the levels of contaminants detected in indoor air are not likely to be associated with adverse health effects. Potential intermittent exposures to subsurface soils would also be unlikely to result in adverse health effects. No exposures to groundwater were identified.

- December 8, 2000: ATSDR released a final health consultation, "Review of March 2000 Sediment and Surface Water Data," which evaluated surface water and sediment data from the Missouri Department of Natural Resources. ATSDR determined from the data provided that exposures to on-site surface water and sediment in the tank berms and off-site surface water and

sediment in the drainage ditch and seepage areas would not be expected to result in adverse health effects. However, because the data were limited, ATSDR recommended additional off-site surface water and sediment sampling in the seepage area and the drainage ditch.

- December 8, 2000: ATSDR released a final health consultation, "Indoor Air in Two Residences in the Norledge Area," which evaluated indoor air sampling data from the Amoco Oil Company. After reviewing the data provided, ATSDR determined that indoor air exposures to the levels detected would not be expected to produce adverse health effects.

- December 19, 2000: ATSDR released a final health consultation, "Review of 1996 Water and Soil Data," which evaluated water and soil data from the Norledge area. ATSDR determined from the data provided that exposures to water and soil by children playing in Sugar Creek should not result in adverse health effects. However, because the data were limited, ATSDR recommended additional surface water and sediment sampling in Sugar Creek.

- April 23, 2001: ATSDR released a final health consultation, "Review of October 2000 Soil and Surface Water Data," which evaluated surface water and soil data provided by the Environmental Protection Agency. ATSDR determined from the data provided that intermittent exposures to surface water and subsurface soil in Sugar Creek and the seepage area would not be expected to result in adverse health effects.

- June 25, 2001: ATSDR released a final health consultation, "Review of Ambient Air Data," which evaluated ambient (outdoor) air sampling data collected by the Missouri Department of Natural Resources. After reviewing the data provided, ATSDR determined that ambient air exposures in the Norledge area would not be expected to produce adverse health effects.

- November 19, 2001: ATSDR provided technical assistance by reviewing the results of one surface water and one soil sample collected at the intersection of Carlisle and Northern streets in Sugar Creek, Missouri. ATSDR determined that the levels of chemicals detected in the water and soil samples are unlikely to result in adverse health effects.

- September 17, 2002: ATSDR provided technical assistance to EPA by reviewing the results of surface water and sediment samples collected in Sugar Creek, Missouri. After reviewing the limited data provided, ATSDR determined that surface water and sediment sampling results indicated levels of chemicals that are unlikely to result in adverse health effects.

- May 20, 2004: ATSDR's March 2000 public health assessment addendum was released in final form and included the agency's responses to comments received on the initial public comment version. ATSDR determined current, chronic exposures to the contaminant levels detected in indoor air are not likely to be associated with adverse health effects.

Actions Planned:

- ATSDR will evaluate additional environmental data for the Norledge area for public health significance, upon request. Results of these evaluations will be provided to the public in subsequent ATSDR documents.

Public Comment

ATSDR released this health consultation for public review and comment from May 1, 2000, through June 13, 2000. Appendix E contains both the comments received during the public comment period and ATSDR's responses to those comments.

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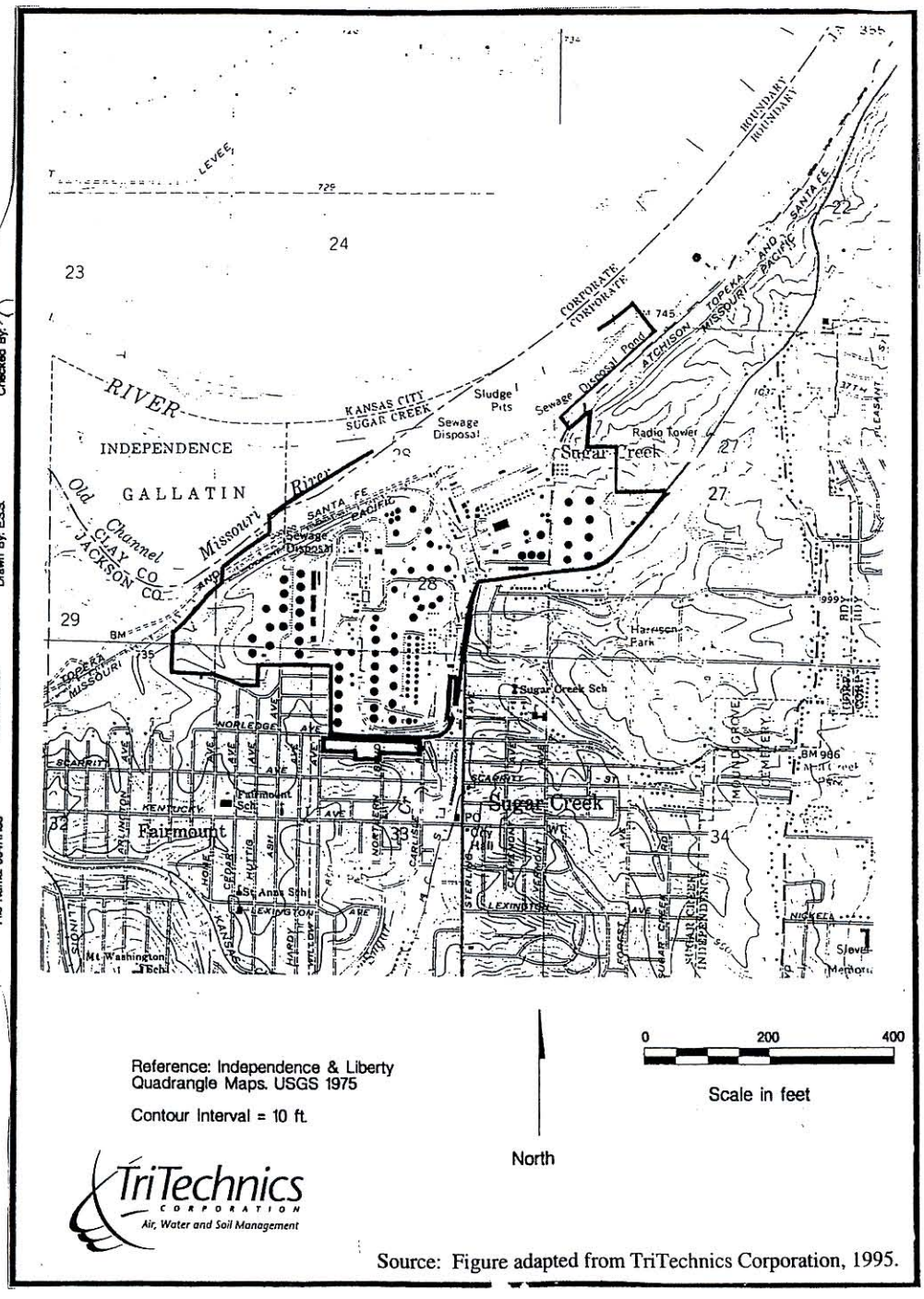
Appendix A – Figures

Figure 1: Amoco Oil Company Site Location Map



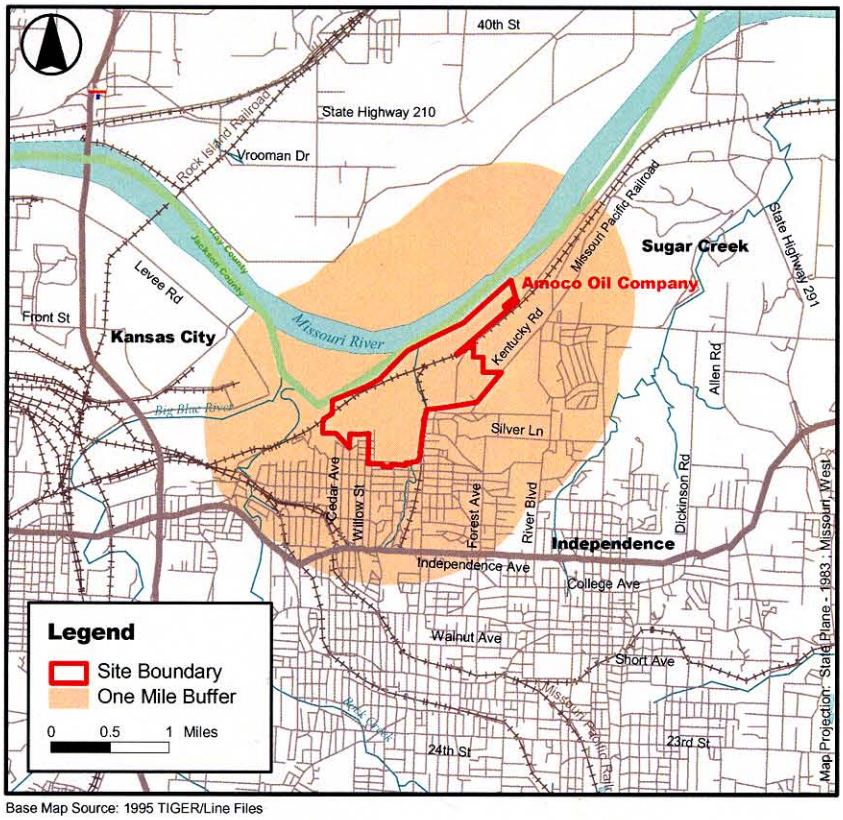
Source: Figure adapted from TriTechnics Corporation, 1995.

Amoco Oil Company

INTRO MAP

Sugar Creek, Missouri

EPA Facility ID MOD007161425



Base Map Source: 1995 TIGER/Line Files

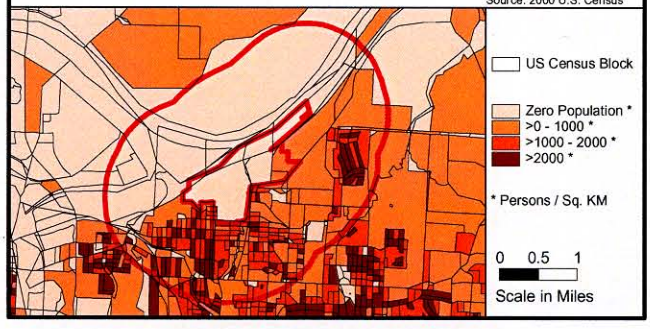
Site Location

Jackson County, Missouri

Demographic Statistics Within Area of Concern*	
Total Population	9708
White alone	8952
Black alone	137
Am. Indian and Alaska Native alone	68
Asian alone	62
Native Hawaiian and Other Pacific Islander alone	96
Some other race alone	159
Two or More races	238
Hispanic or Latino	383
Children Aged 6 and Younger	927
Adults Aged 65 and Older	1393
Females Aged 15 - 44	1933
Total Housing Units	4446

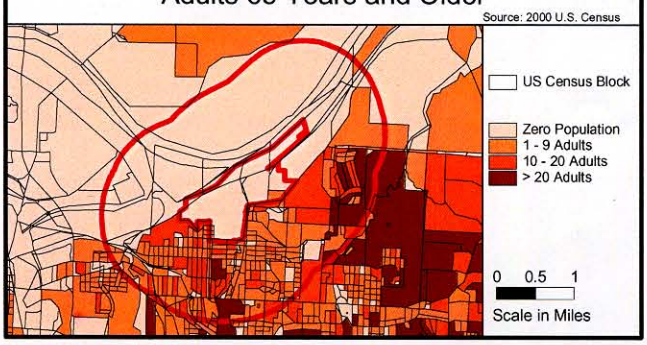
Demographics Statistics Source: 2000 US Census
*Calculated using an area-proportion spatial analysis technique

Population Density

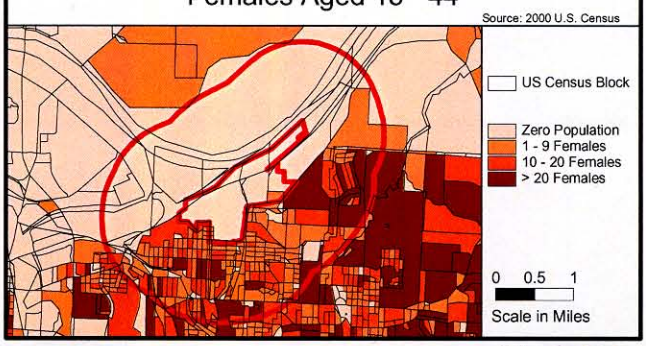


Children 6 Years and Younger

Adults 65 Years and Older



Females Aged 15 - 44



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Appendix B – Tables

Table 1: Off-site Exposure Pathway Elements

Pathway Name	Exposure Pathway Elements					Time Frame
	Source	Media	Point of Exposure	Route of Exposure	Exposed Population	
Completed Exposure Pathway						
Soil	Unknown	Surface Soil	Norledge area	Dermal; Ingestion; Inhalation of dust	Residents who disturb the soil (e.g., gardening, playing)	Current; Future

Table 2: Results of February 2000 Off-Site Soil Sampling*

Compound	Composite Sample Concentration Range (ppm)	Grab Sample Concentration Range (ppm)	Comparison Value (ppm)	Source††
Semi-volatile Organic Compounds				
Benzo(a)anthracene	ND–0.35	NT	0.1	CREG†
Benzo(b)fluoranthene	ND–0.43	NT	0.1	CREG†
Benzo(k)fluoranthene	ND–0.42	NT	0.1	CREG†
Bis(2-ethylhexyl) phthalate	ND; 0.39 (1 detection)	NT	50 40 1,000 10,000	CREG RMEG (pica child) RMEG (child) RMEG (adult)
Chrysene	ND–0.65	NT	0.1	CREG†
Fluoranthene	ND–1.2	NT	80 2,000 30,000	RMEG (pica child) RMEG (child) RMEG (adult)
Hexachlorobenzene	ND; 0.16 (1 detection)	NT	0.4 0.04 1 10	CREG Chronic EMEG (pica child) Chronic EMEG (child) Chronic EMEG (adult)
Indeno(1,2,3-cd) pyrene	ND; 0.32 (1 detection)	NT	0.1	CREG†
Phenanthrene	ND–0.91	NT	40 1,000 10,000	Intermediate EMEG‡ (pica child) Intermediate EMEG‡ (child) Intermediate EMEG‡ (adult)
Pyrene	ND–1.0	NT	60 2,000 20,000	RMEG (pica child) RMEG (child) RMEG (adult)
Metals				
Aluminum	6,280–14,600	5,200–13,500	78,000	Region III Residential RBC (N)
Arsenic	ND; 8.22 (1 detection)	ND	0.5 0.6 20 200	CREG Chronic EMEG (pica child) Chronic EMEG (child) Chronic EMEG (adult)
Barium	151–192	158–203	100 4,000 50,000	RMEG (pica child) RMEG (child) RMEG (adult)

Compound	Composite Sample Concentration Range (ppm)	Grab Sample Concentration Range (ppm)	Comparison Value (ppm)	Source[††]
Cadmium	ND–1.88	ND–2.74	0.4 10 100	Chronic EMEG (pica child) Chronic EMEG (child) Chronic EMEG (adult)
Calcium	2,750–41,200	2,720–13,400	NA	—
Chromium	9.18–19.4	7.25–16.2	6 200 2,000	RMEG[§] (pica child) RMEG[§] (child) RMEG[§] (adult)
Cobalt	5.15–7.52	4.49–8.18	4,700	Region III Residential RBC (N)
Copper	9.63–16.9	10.0–20.3	3,100	Region III Residential RBC (N)
Iron	8,470–14,900	7,250–14,700	23,000	Region III Residential RBC (N)
Lead	15.7–82.4	22.7–88.8	400	EPA Revised Interim Guidance[¶]
Magnesium	1,590–3,390	1,730–2,880	NA	—
Manganese	430–1,060	510–779	100 3,000 40,000	RMEG (pica child) RMEG (child) RMEG (adult)
Mercury	0.023–0.081	0.019–0.090	0.6 20 200	RMEG[**] (pica child) RMEG[**] (child) RMEG[**] (adult)
Nickel	12.2–18.2	10.4–18.2	40 1,000 10,000	RMEG (pica child) RMEG (child) RMEG (adult)
Potassium	1,280–2,570	1,310–2,120	NA	—
Sodium	72.7–182	81.5–155	NA	—
Vanadium	18.0–39.0	14.9–33.6	6 200 2,000	Intermediate EMEG (pica child) Intermediate EMEG (child) Intermediate EMEG (adult)
Zinc	64.8–282	82.0–266	600 20,000 200,000	Chronic EMEG (pica child) Chronic EMEG (child) Chronic EMEG (adult)

* Source: Environmental Protection Agency. 2000. March 7 data transmittal report from Michael Thomas, EPA Regional Laboratory, to Robert Aston, EPA. Subject: transmittal of sample analysis results for ASR #474, activity number: REA01, activity description: Amoco refinery.
Date sampled: February 2000.

† Comparison value for benzo(a)pyrene.

‡ Comparison value for naphthalene.

§ Comparison value for hexavalent form.

¶ Based on the EPA 'Revised Interim Soil Lead Guidance for CERCLA sites and RCRA Corrective Action Facilities' (Directive 9355.4-12) 1994.

** Comparison values for mercuric chloride.

†† When this health consultation was released for public comment in May 2000, ATSDR used chronic duration (for a year to a lifetime) pica child soil comparison values (SCVs) and intermediate duration (2 weeks to a year) pica child SCVs to screen contaminant data. Recently, however, ATSDR began to eliminate its pica child SCVs because several factors make it unlikely that a pica child could receive a toxic dose of chemicals from soil ingestion, alone. Chronic duration pica child SCVs have already been eliminated. Because this process is not yet complete, ATSDR chose to include the agency's former pica values (chronic and intermediate) in this table.

CREG	Cancer risk evaluation guide
EMEG	Environmental media evaluation guide
NA	Not applicable. Calcium, magnesium, potassium, and sodium are considered essential nutrients and do not exert toxic effects at low levels.
ND	Not detected
NT	Not tested. Grab samples were not analyzed for semi-volatile organic compounds.
ppm	parts per million
RBC (N)	Risk-based concentration (noncarcinogenic)
RMEG	Reference dose media evaluation guide

Appendix C – Comparison Values

ATSDR comparison values are media-specific concentrations considered safe under default conditions of exposure. They are used as screening values in the preliminary identification of site-specific "contaminants of concern." The latter term should not be misinterpreted as an implication of "hazard." As ATSDR uses the phrase, a "contaminant of concern" is a chemical substance detected at the site in question and selected by the health assessor for further evaluation of potential health effects. Generally, a chemical is selected as a "contaminant of concern" because its maximum concentration in air, water, or soil at the site exceeds one of ATSDR's comparison values.

It must however be emphasized that comparison values are not thresholds of toxicity. Although concentrations at or below the relevant comparison value can reasonably be considered safe, it does not automatically follow that any environmental concentration exceeding a comparison value would be expected to produce adverse health effects. The principal purpose behind protective health-based standards and guidelines is to enable health professionals to recognize and to resolve potential public health hazards before they become actual public health consequences. For that reason, ATSDR's comparison values are typically designed to be 1 to 3 orders of magnitude (or 10 to 1,000 times) lower than the corresponding no-effect levels (or lowest-effect levels) on which they are based. The probability that such effects will actually occur depends not on environmental concentrations alone. Rather, the probability depends on a unique combination of site-specific conditions and individual lifestyle and genetic factors that affect the route, magnitude, and duration of actual exposure.

Listed and described below are the various comparison values that ATSDR uses to select chemicals for further evaluation, as well as other non-ATSDR values that are sometimes used to put environmental concentrations into a meaningful frame of reference.

CREG	=	Cancer Risk Evaluation Guides
MRL	=	Minimal Risk Level
EMEG	=	Environmental Media Evaluation Guides
IEMEG	=	Intermediate Environmental Media Evaluation Guide
RMEG	=	Reference Dose Media Evaluation Guide
RfD	=	Reference Dose
RfC	=	Reference Dose Concentration
RBC	=	Risk-Based Concentration
MCL	=	Maximum Contaminant Level

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations expected to cause no more than one excess cancer in a million persons exposed over a lifetime. CREGs are

calculated from EPA's cancer slope factors, or cancer potency factors, using default values for exposure rates.

Minimal Risk Levels (MRL) are estimates of daily human exposure to a chemical (doses expressed in mg/kg/day) that are unlikely to be associated with any appreciable risk of deleterious noncancer effects over a specified duration of exposure. MRLs are calculated using data from human and animal studies and are reported for acute (≤14 days), intermediate (15–364 days), and chronic (≥365 days) exposures. MRLs are published in ATSDR Toxicological Profiles for specific chemicals.

Environmental Media Evaluation Guides (EMEGs) are concentrations that are calculated from ATSDR minimal risk levels by factoring in default body weights and ingestion rates.

Intermediate Environmental Media Evaluation Guides (IEMEG) are calculated from ATSDR minimal risk levels; they factor in body weight and ingestion rates for intermediate exposures (those occurring for more than 14 days and less than 1 year).

Reference Dose Media Evaluation Guide (RMEG) is the concentration of a contaminant in air, water or soil that corresponds to EPA's RfD for that contaminant when default values for body weight and intake rates are taken into account.

Reference Dose (RfD) is an estimate of the daily exposure to a contaminant unlikely to cause noncarcinogenic adverse health effects. Like ATSDR's MRL, EPA's RfD is a dose expressed in mg/kg/day.

Reference Concentrations (RfC) is a concentration of a substance in air that EPA considers unlikely to cause noncancer adverse health effects over a lifetime of chronic exposure.

Risk-Based Concentrations (RBC) are media-specific concentrations derived by Region III of the Environmental Protection Agency from RfDs, RfCs, or EPA's cancer slope factors. They represent concentrations of a contaminant in tap water, ambient air, fish, or soil (industrial or residential) that are considered unlikely to cause adverse health effects over a lifetime of chronic exposure. RBCs are based either on cancer ("c") or noncancer ("n") effects.

Maximum Contaminant Levels (MCLs) represent contaminant concentrations in drinking water that EPA deems protective of public health (considering the availability and economics of water treatment technology) over a lifetime (70 years) at an exposure rate of 2 liters of water per day.

Threshold Limit Values (TLVs) are time-weighted average concentrations for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

Appendix D – ATSDR Methodology

The Agency for Toxic Substances and Disease Registry (ATSDR) addresses the question of whether exposure to contaminants at the maximum concentrations detected would result in adverse health effects. While the relative toxicity of a chemical is important, the human body's response to a chemical exposure is determined by several additional factors, among which are

- the concentration (how much) of the chemical to which the person was exposed,
- the amount of time the person was exposed (how long), and
- the way the person was exposed (through breathing, eating, drinking, or direct contact with something containing the chemical).

Lifestyle factors (for example, occupation, and personal habits) have a major affect on the likelihood, magnitude, and duration of exposure. Individual characteristics such as age, sex, nutritional status, overall health, and genetic constitution affect how a human body absorbs, distributes, metabolizes, and eliminates a contaminant. A unique combination of all these factors will determine the individual's physiologic response to a chemical contaminant and any adverse health effects the individual may suffer as a result of the chemical exposure.

ATSDR evaluates contaminants detected in environmental media at a site and determines whether an exposure to them has public health significance. ATSDR begins this evaluation by gathering reports that contain relevant environmental data for the site. These data are reviewed to determine whether contaminant levels are above health-based comparison values. Health-based comparison values are estimates of the daily human exposure to a substance that are not likely to result in adverse health effects over a specified duration of exposure. These values are developed for specific media (such as air and water) and for specific durations of exposure (such as acute and chronic).

Comparison values represent conservative levels of safety and not thresholds of toxicity. Thus, although concentrations at or below a comparison value may reasonably be considered safe, concentrations above a comparison value will not necessarily be harmful. Comparison values are intentionally designed to be much lower, usually by orders of magnitude, than the corresponding no-effect levels (or lowest-effect levels) determined in laboratory studies to ensure that even the most sensitive populations (such as children or the elderly) are protected.

To determine whether people are being exposed to contaminants or whether they were exposed in the past or will be exposed in the future, ATSDR examines the path between a contaminant and a person or group of people who could be exposed. Completed exposure pathways have five required elements. ATSDR evaluates each possible pathway at a site to determine whether all

five factors exist and people are being exposed, were exposed, or may be exposed in the future. These five factors or elements must exist for a person to be exposed to a contaminant:

(1) a source of contamination
(2) transport through an environmental medium
(3) a point of exposure
(4) a route of human exposure, and
(5) an exposed population.

ATSDR classifies exposure pathways in one of the following three categories.

- *Completed Exposure Pathway*. ATSDR calls a pathway "complete" if it is certain that people are exposed (or were exposed or will be exposed) to contaminated media. Completed pathways require that the five elements exist and indicate that exposure to the contaminant has occurred, is occurring, or will occur.

- *Potential Exposure Pathway*. Potential pathways are those in which at least one of the five elements is missing, but could exist. Potential pathways indicate that exposure to a contaminant could have occurred, could be occurring, or could occur in the future.

- *Eliminated Exposure Pathway*. In an eliminated exposure pathway, at least one of the five elements is missing and will never be present. From a human health perspective, pathways can be eliminated from further consideration if ATSDR is able to show that (1) an environmental medium is not contaminated or that (2) no one is exposed to contaminated media.

Appendix E – Public Comments

The Agency for Toxic Substances and Disease Registry (ATSDR) released this "Amoco Oil Company Heath Consultation, Review of February 2000 Soil Data," for public review and comment from May 1, 2000, through June 13, 2000. Each comment received was logged and became part of the administrative record. This appendix contains both the comments received during the public comment period and ATSDR's response to those comments. The comments have been numbered with the response directly below each comment.

Comment 1: *You have produced two reports, which in and of itself, is confusing. The ATSDR report is a shorter version of Tetra Tech's report to the Environmental Protection Agency (EPA) Region VII.*

Response 1: ATSDR requested surface soil sampling in the residential Norledge area. EPA contracted Tetra Tech to collect the samples. Tetra Tech submitted a report summarizing the analytical data to the EPA. This health consultation provides ATSDR's independent public health evaluation of the soil sampling data.

Comment 2: *The data on which this health consultation was based was not available until 10 days after the health consultation was made available to the public. The information from this report is crucial in order for anyone to comment properly. You should consider this for future disbursement protocols.*

Response 2: The soil data were available to the public, as they are presented in this health consultation (see Table 2, Appendix B).

Comment 3: *In the Discussion section, you discuss dermal contact as being the primary route of exposure, with potential incidental ingestion and inhalation of dust as secondary routes. We disagree. Since so many exposure areas (most of which were not sampled) are within the boundaries of Sugar Creek and Independence and are not fenced off to prevent exposure, it would be irresponsible to assume that some exposures are "incidental." There are children that live in both these towns that play in the dirt, the creeks, and breathe the air, doing what kids do. They are not restricted from known harmful chemical exposures. For example, we have sent photos of a place adjacent to the refinery where children were digging in the dirt, climbing the trees, teetering over the fence. These kids were barefoot and covered with dirt. Inhalation or ingestion cannot be considered "incidental."*

Response 3: ATSDR modified the health consultation to indicate ingestion and inhalation are also primary routes of exposure. However, this change does not affect the agency's conclusions.

Comment 4: *We expected to see some data in your report from the Ohio and Carlisle creek/seep/drainage ditch, where high levels of toxic metals have been found. Children have been seen numerous times fishing, playing and wading.*

Response 4: The purpose of this health consultation is to evaluate the public health significance of surface soil samples collected in February 2000. During separate sampling events, EPA and the Missouri Department of Natural Resources (MDNR) sampled seeps and other areas of concern. ATSDR evaluated surface water and sediment data in separate health consultations (see the Public Health Action Plan section).

Comment 5: *We disagree even more with your determination that "incidental inhalation or ingestion of dust [are] secondary routes" of exposure since it has come to our attention that there is a swimming hole, frequently used by neighborhood children, just down from the Ohio and Carlisle creek seep. This particular seep (found relatively recently) is only 100 yards from the kid's swimming hole and about 150 feet from there high levels of toxic metals were found. The Ohio and Carlisle creek seep has exhibited a tremendous amount of iron bacterial growth, a likely indicator of petroleum pollution. We do not believe that it is appropriate to determine that inhalation or ingestion is an "incidental" exposure, given that soil particles are likely to be ingested and inhaled when children frequently swim and play in the soil lined creek.*

Response 5: Please see Responses 3 and 4.

Comment 6: *We are perplexed as to how EPA decided which sites to sample. Moreover, it seems that EPA, ATSDR, and MDNR habitually cling to phantom boundary lines known as "Norledge" and "zones A, B, C."*

Response 6: Please contact EPA directly to discuss how the specific sampling locations were chosen.

Comment 7: *The choice of the sites do not necessarily coincide with the purpose (e.g., collection from areas where adults and children would have frequent access to, like home gardens and playgrounds.)*

Response 7: Samples were collected from 13 residences, including one commercial garden, and two municipal parks (Tetra Tech 2000).

Comment 8: *Had ATSDR, EPA, and MDNR paid attention to all the photos and emails sent by concerned citizens (or had taken us up on the off-site walk what we have begged for) you would have know where to sample, based on all the seeps, leaks, and other areas of concern.*

Response 8: As stated previously, this health consultation addresses soil samples collected at ATSDR's request. During separate sampling events, EPA and MDNR sampled seeps and other

areas of concern. ATSDR evaluated these data in separate health consultations (see the Public Health Action Plan section).

Comment 9: *In the Tetra Tech report to the EPA, it is noted that on residence G a "potential seep" was sampled. After reviewing all diagrams and photos of the residences, we believe that you should have tested where the seeps had been reported on this property, instead of away from the seep.*

Response 9: Although Tetra Tech indicated a potential seep was sampled, ATSDR considered this sample a soil sample and evaluated the results along with the other data.

Comment 10: *Your background sites make no sense. Sample #015 is located east of Sugar Creek and west of an area known as the Ponderosa, a wooded area with three ponds. Just north of that area there is a documented pipeline leak. No one knows if it was ever properly cleaned up and topographic maps suggest that sample area #015 could be affected by that leak, making any comparison as a "normal" or "background" level useless.*

Response 10: ATSDR did not consider any of the soil samples as "background samples." The maximum levels of each chemical for all samples were evaluated for public health significance.

Comment 11: *Similarly, "background" site #016, although south of the "Norledge" area, is located near Carlisle and Ohio. This place has been entirely filled in with refinery refuse. This makes it useless as "normal background" level. Further, we believe that it is ridiculous to use any so-called "background" level, since cleanup to safe maximums should be the criteria. Are Sugar Creek and Independence any different from Overland Park, Kansas?*

Response 11: Please see Response 10.

Comment 12: *The ATSDR report inaccurately characterized the depth of soil samples for site #006.*

Response 12: ATSDR modified the depth of this garden soil sample in the text of the health consultation.

Comment 13: *Out of 26 samples, 17 were composite samples, which means the amount reported is an average, not a specific reading. Thus, we have no idea what the highest single recorded concentration is, which is in direct conflict with ATSDR's own criteria.*

Response 13: Soil composite sampling and soil grab sampling methods each have benefits and limitations. For the February 2000 sampling event, soil samples included both types of methods. ATSDR considers these data appropriate for public health evaluation.

Comment 14: *The 17 composite samples were analyzed for SVOCs and metals and the nine grab samples were analyzed for VOCs and metals, yet this was done without any explanation. All of these samples should have been taken exactly the same way and for the same contaminants.*

Response 14: Please see Response 13.

Comment 15: *We are not satisfied with the contaminants chosen for testing. Your list is severely limited. We find it strange that the soil sampling results do not mention BTEXs (benzene, toluene, ethyl benzene, or xylene), given that these have been the primary focus of the Sugar Creek investigation. Why weren't these sampled or discussed.*

Response 15: The soil grab samples were analyzed for volatile organic compounds (VOCs), including BTEX, but none were detected. The text in Discussion section has been modified to make this clarification.

Comment 16: *Methyl-tert-butyl ether (MTBE), although it was found in area wells, was not tested for. Our concern is heightened, as we recently learned that at least eight sites (nearly all residential) in the area show MTBE concentrations. Seven of these eight are residential properties near the refinery.*

Response 16: ATSDR will revise its public health conclusion if additional data that are provided to the agency lead to a conclusion that is not consistent with what has previously been determined. ATSDR evaluated MTBE in other documents. ATSDR reviewed limited sampling for MTBE in subsurface soil in a November 2000 public health assessment and a November 2001 health consultation (see the Public Health Action Plan section). The results indicated MTBE was either not detected or it was detected at levels below ATSDR health-based comparison values.

Comment 17: *The eighth MTBE site (see previous comment 16), which we were recently informed by the MDNR, is an MTBE-tainted area (Outfall #004) north of the refinery. We have been sending e-mails and photos of this outfall to regulators for many months. The Outfall exhibited a substantial amount of "orange goo," the iron bacterial growth, which is again, a likely symptom of pollution. This outfall leads to the Missouri River and its permit status is being questioned by the MDNR. It is near the Independence public water supply and people (including a 17-year-old boy who recently drowned there) are known to fish and play there. Surely, this warrants some investigation by those assessing public health in Sugar Creek.*

Response 17: Please see Responses 4 and 16.

Comment 18: *You do not take into consideration the interactive or cumulative effects of chemicals. These things do not behave in nice, linear patterns, like many would like them to.*

Response 18: The combined effect of the contaminants detected in soil was evaluated and determined not to be of health concern.

Comment 19: *We question why the soil data produced in the Tetra Tech report to the EPA was the only soil data evaluated in the ATSDR report. There is other soil data available to you, all of which is relevant to your public health assessment in the Sugar Creek/Independence area. For instance, Dr. [Syed E.] Hasan of the Geosciences and Environmental Sciences Department at the University of Missouri-Kansas City produced soil data from the residential area. Why was this data not included? He was presented with an award (1999) by EPA Region VII. Surely, his credibility is not in question.*

Response 19: ATSDR responded to requests to review data and did so through a series of public health assessments and health consultations (see the Public Health Action Plan section). This health consultation focused solely on the February 2000 sampling event.

Comment 20: *The MDNR recently gathered soil samples. Their samples from the Ohio and Carlisle area showed levels of toxic metals at much higher rates than those in upper Sugar Creek on the BPA refinery. Isn't this a concern? Wouldn't these soil data be crucial to your assessment? Why weren't these included in your evaluation?*

Response 20: Please see Responses 4 and 19.

Comment 21: *How can the ATSDR have no specific recommendations? Sample to bedrock? Further sampling after the drought is over? More sampling sites? A bigger list of chemicals to include for testing? 50-foot grid patterns so that the residential area will be fully characterized? Inclusion of all areas we have discovered that may be potentially harmful to anyone? Inclusion of sample results taken by regulators on-site in March?*

Response 21: ATSDR made no specific recommendations because the soil data evaluated in this health consultation did not indicate a public health hazard.

Comment 22: *If ATSDR is making the decision that due to these soil sampling results, there is no apparent health hazard, ATSDR is not doing their homework. There isn't enough data to confirm anything except there isn't enough data.*

Response 22: ATSDR considers the data adequate for a public health evaluation.

Comment 23: *With regard to the arsenic found at Residence E, the report is silent as to the ingestion pathway for produce grown in the garden and then consumed by the property owner or sold to the public.*

Response 23: The concentrations of arsenic in soil varies widely, generally ranging from about 1

to 40 parts per million (ppm), with an average level of 5 ppm (ATSDR 2000). The level of arsenic found in this garden soil sample, 8 ppm, is close to the average level found in soil. For this level of arsenic in soil, no adverse health effects from arsenic exposure would be expected in people who consume garden produce grown in this soil.

Comment 24: *The EPA report that summarizes the surface soil results states that elevated arsenic was detected in a garden. It should be noted that arsenic can be found in some pesticides and fertilizers.*

Response 24: Comment noted.

Comment 25: *The Tetra Tech report expresses the opinion that the arsenic level found in Residence E may be the result of pesticide application. Please explain what support Tetra Tech has for expressing this opinion. Did the ATSDR give any credibility to the opinion? Please note that since the resident at Residence E and the Tetra Tech representative never spoke to each other, they would have never discussed pesticides.*

Response 25: ATSDR noted, in these responses to comments, that arsenic is found in some pesticides and fertilizers.

Comment 26: *We believe it is highly unlikely that the refinery is the source of potential contaminants in the off-site surface soils. The report as written potentially misleads the reader into thinking that there is a complete exposure pathway as the result of refinery operations. It may be more accurate to represent the exposure pathway as "potentially complete," as defined in Appendix D of this report.*

Response 26: There is a completed exposure pathway to surface soil. ATSDR modified Table 1, Appendix B, to indicate the source is unknown.

Comment 27: *The concentration of contaminants in surface soil should be put into perspective. For example, the detected metal concentrations could be compared to background concentrations to show that the levels are not elevated above those in the region.*

Response 27: In this health consultation, ATSDR evaluated exposure to the detected levels of contaminants, regardless of background concentrations.

Comment 28: *The ATSDR report should also consider and comment on the analysis results for the split samples taken by Amoco Oil representatives.*

Response 28: ATSDR obtained the results of the split samples collected by Amoco during this February 2000 soil sampling event (ATSDR 2003). The results indicate levels of contaminants within the same ranges as reported in this health consultation. No adverse health effects are

expected at the levels detected.

Comment 29: *The report could be more direct in distinguishing that the sampling was to detect current levels of contaminants, not levels of contaminants to which the residents were exposed, either during the refinery's operations or in the years immediately after the refinery's closure.*

Response 29: ATSDR modified the report to indicate the contaminant levels are representative of current and future exposure levels.

Comment 30: *The point should be clearly made that this sampling is occurring 18 years after the refinery ceased operations.*

Response 30: ATSDR notes in Background section that refinery operation ceased in 1982.

Comment 31: *Please explain why Tetra Tech did not follow the EPA's SW 846 methodology (i.e., 5035 protocol) in sampling for VOCs from the properties.*

Response 31: Please contact Tetra Tech or EPA to inquire about their sampling methodologies.

Comment 32: *The reference to CERCLIS No. in the text and figures should be changed to the RCRIS No.*

Response 32: ATSDR deleted the designation "CERCLIS No." on all text and figures and replaced it with the designation "EPA Facility ID."

Comment 33: *The last sentence in the 5th paragraph of the Discussion section should be revised. The reference to "the Amoco site" should be changed to "in the residential area." The soils data presented represent residential soils and were not collected from the Amoco site property. The sentence as written could mislead the reader to assume that arsenic levels on the Amoco site are not likely to produce adverse health effects.*

Response 33: ATSDR modified the sentence.

References:

[ATSDR] Agency for Toxic Substances and Disease Registry. 2000. Toxicological profile for arsenic (update). Atlanta: US Department of Health and Human Services. Available at URL: http://www.atsdr.cdc.gov/toxprofiles/tp2.html.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2003. December 17 routing and transmittal package from Denise Jordan-Izaguirre to Danielle Langmann containing analytical data validation and reports of laboratory analysis from a February 2000 soil sampling event. Kansas City, Kansas: ATSDR Region 7.

[Tetra Tech] Tetra Tech EM Inc. 2000. March 29 surface soil sampling report for properties near the former Amoco refinery. Prepared for the US Environmental Protection Agency, Region 7, work assignment, R07814. Lenexa, Kansas.